INPUT AND OUTPUT

Unclassified

RISK ASSESSMENT: *Low*

SAFETY CONSIDERATIONS:

Electrical Shock Hazard

Electrostatic Discharge

ENVIRONMENTAL CONSIDERATIONS:

None

TERMINAL LEARNING OBJECTIVE

ACTION: **Communicate how the 8086 sends and receives data using the Input/Output ports.**

CONDITIONS: **Given a classroom environment, Computer Aided Instruction (CAI) workstation and official OMEMS reference material.**

STANDARDS: **Correctly answer 18 of 25 questions correctly on how the 8086 microprocessor sends and receives data using the Input/Output ports.**

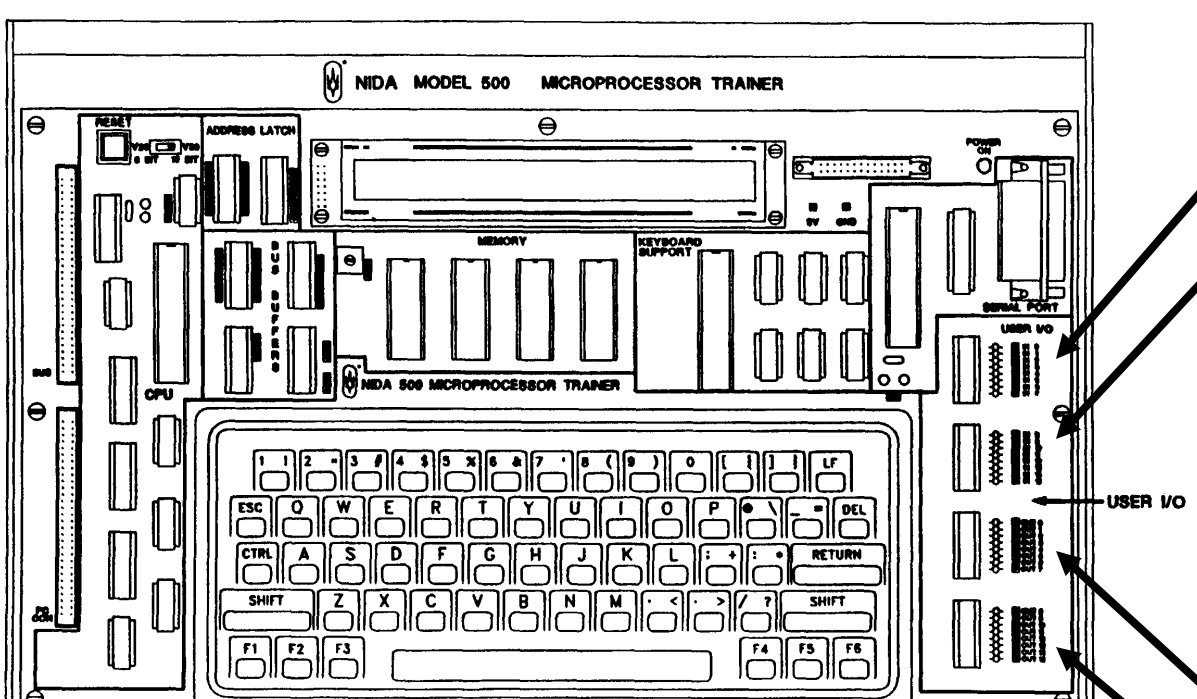
ENABLING LEARNING OBJECTIVE

ACTION: Define the microprocessor's input and output operation.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

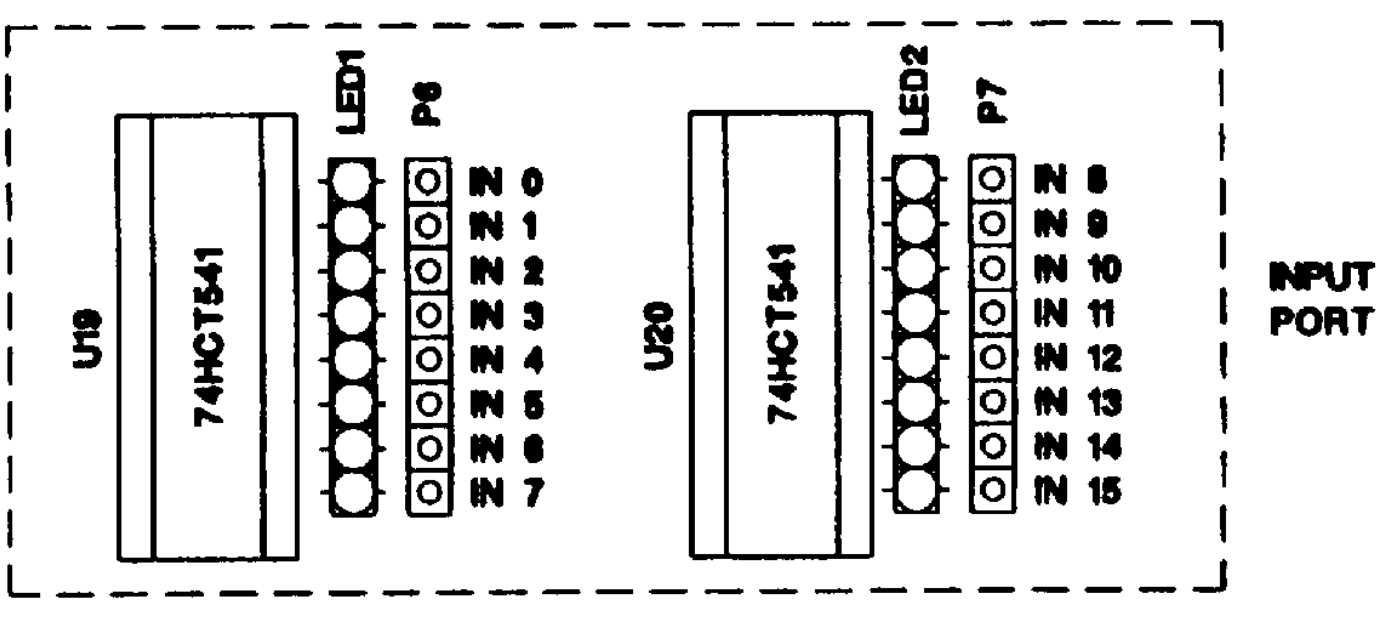
STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

USER I/O



CF351K06-05

Input Port

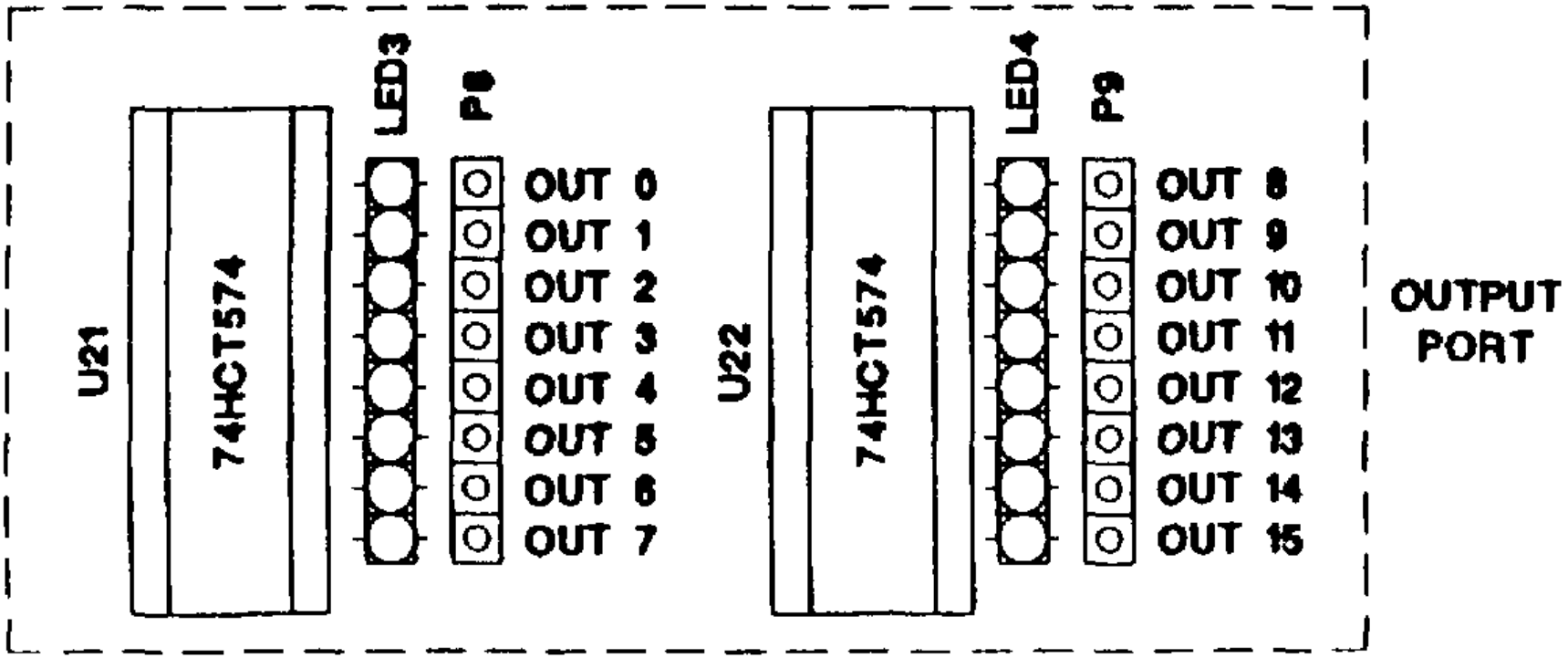


LOW BYTE

HIGH BYTE

CF351K06-0

Output Port



LOW BYTE HIGH BYTE

CF351K06-0

IN port (Input)

(AX) ⟵ (word)

(AL) ⟵ (byte)

CODE	MNEMONIC	PSEUDOCODE
E5	IN 70 (AX)	Move word from user I/O Port to AX
E4	IN 70 (AL)	Move low order 70 byte form User I/O Port to AL

OUT port (Output)

(word) ⟵ (AX)

(byte) ⟵ (AL)

CODE	MNEMONIC	PSEUDOCODE
E7 70	OUT 70 (AX)	Move word in AX to User I/O Port.
E6 70	OUT 70 (AL)	Move low order byte in AL to User I/O Port

INPUT/OUTPUT PROGRAM

ADDRESS	OP CODE	MNEMONIC	PSEUDOCODE
1000	B8	MVI AX, FEC9	Move FEC9 into AX
1001	C9		
1002	FE		
1003	E7	OUT 70	Send AX to port 70
1004	70		
100A	CD	HALT	STOP
100B	20		

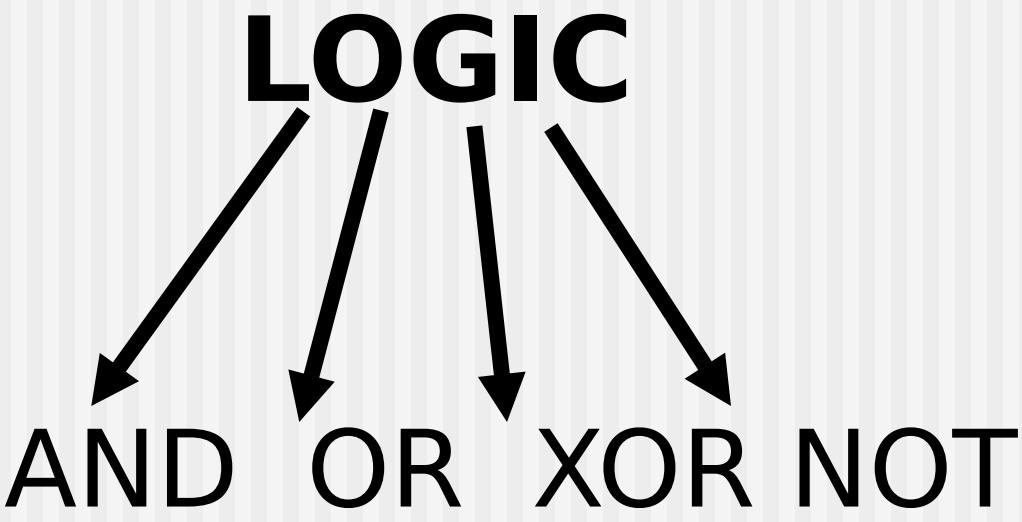
ENABLING LEARNING OBJECTIVE

ACTION: Describe the use of logical operations in the 8086 processor.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

LOGIC INSTRUCTIONS



ENABLING LEARNING OBJECTIVE

ACTION: Describe the use of AND operations.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

AND LOGIC INSTRUCTION

DEAD
FOFO

BEEF
OFOF

INPUT A	INPUT B	OUTPUT
0	0	0
0	1	0
1	0	0
1	1	1

AND INSTRUCTIONS

- AND IMMEDIATE WITH ACCUMULATOR, REGISTER OR MEMORY.
- AND REGISTER WITH REGISTER, OR REGISTER WITH MEMORY.

ANA data
(AND immediate data with AL or AX Reg)

CODE	MNEMONIC	PSEUDOCODE
24 F0	ANA F0	AND F0 with AL
25 F0 F0	ANA F0F0	AND F0F0 with AX

ENABLING LEARNING OBJECTIVE

ACTION: Describe the use of OR operations.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

OR LOGIC INSTRUCTION

OEOF
DOAO

INPUT		OUTPUT
A	B	
0	0	0
0	1	1
1	0	1
1	1	1

OR INSTRUCTIONS

- OR IMMEDIATE DATA WITH ACCUMULATOR, REGISTER OR MEMORY.
- OR REGISTER WITH REGISTER OR MEMORY.

OR data
(OR immediate data with AL or AX Reg)

CODE	MNEMONIC	PSEUDOCODE
0C FF	ORA FF	OR FF with AL
0D FF FF	ORA FFFF	OR FFFF with AX

ENABLING LEARNING OBJECTIVE

ACTION: Describe the use of XOR operations.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

XOR LOGIC INSTRUCTION

EDCB
EDCB

INPUT A	INPUT B	OUTPUT
0	0	0
0	1	1
1	0	1
1	1	0

XOR INSTRUCTIONS

- XOR IMMEDIATE DATA WITH ACCUMULATOR, REGISTER OR MEMORY.
- XOR REGISTER WITH REGISTER OR MEMORY.

XOR data
(XOR immediate data with AL or AX Reg)

CODE	MNEMONIC	PSEUDOCODE
34	XRA 33	XOR 33 with AL
33		
35	XRA 3333	XOR 3333 with
33		AX
33		

ENABLING LEARNING OBJECTIVE

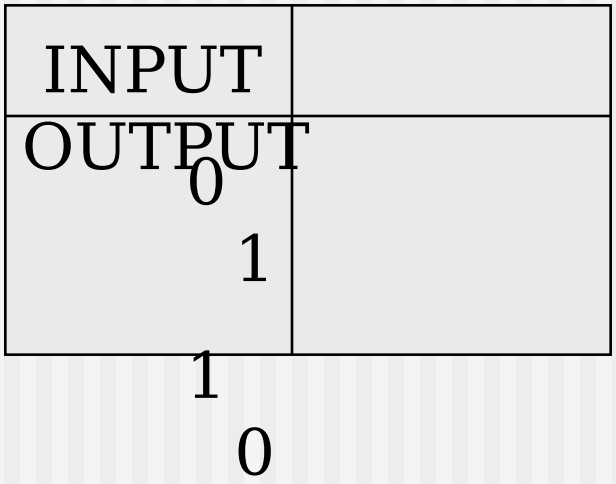
ACTION: Describe the use of NOT operations.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

NOT LOGIC INSTRUCTION

1234



NOT AX
(Complement AX Reg)

CODE	MNEMONIC	PSEUDOCODE
F7	NOT AX	Complement each
D0		bit in the AX

ENABLING LEARNING OBJECTIVE

ACTION: Describe the use of compare operations.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

COMPARE INSTRUCTIONS

COMP, data

CPI M, data

CMP r1, r2

COMP M, r

COMP r, M

CPI r, data

COMPARE INSTRUCTIONS

CONDITION	FLAG REGISTER	
	ZERO	CARRY
A=B	ZR	NC
A>B	NZ	NC
A<B	NZ	CY

COMPARE INSTRUCTIONS

- COMPARE IMMEDIATE DATA WITH ACCUMULATOR, REGISTER OR MEMORY.
- COMPARE REGISTER WITH REGISTER OR MEMORY.

CMP data
(CMP immediate data with AL or AX Reg)

CODE	MNEMONIC	PSEUDOCODE
3C AA	CMP AL, AA	CMP AA with AL
3D AA AA	CMP AX, AAAA	CMP AAAA with AX

ENABLING LEARNING OBJECTIVE

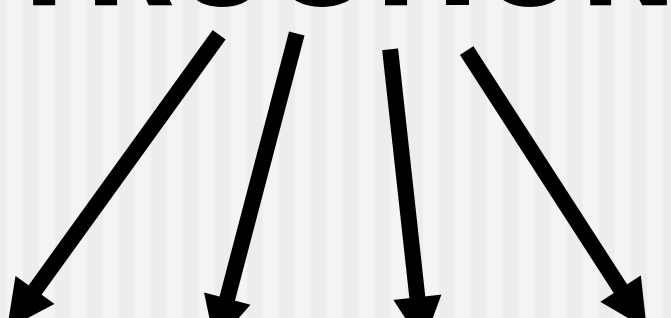
ACTION: Describe the purpose of jump instructions in the 8086 mode.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI), workstation, NIDA electronic trainer, and official OMEMS reference material.

STANDARDS: Correctly answer 18 of 25 questions on how the 8086 microprocessor sends and receives data using the Input/Output ports.

JUMP INSTRUCTIONS

CONTROL INSTRUCTIONS



JMP JZ JNZ JO

JMP address
(Direct within Segment Short Type Jump)

CODE	MNEMONIC	PSEUDOCODE
EB	JMP 05	Jump forward 05
05		

JMP address
(Direct within Segment Short Type Jump)

CODE	MNEMONIC	PSEUDOCODE
EB FB	JMP FB	Jump backwards

JZ displacement (Jump if zero)
JNZ displacement (Jump if not zero)

CODE	MNEMONIC	PSEUDOCODE
74	JZ 05	If ZF =1 then
05		IP=IP +05
75	JNZ FB	IF ZF=0 then
FB		IP=IP+FB

CONDITIONAL/ UNCONDITIONAL JUMPS

ADDRESS	OP CODE	MNEMONIC	I P
1000	EB	JMP 02	1002
1001	02		
1002	90	NO OP	1003
1003	90	NO OP	1004
1004	74	JZ FA	1006
1005	FA		
1006	CD	HALT	1008
1007	20		

SUMMARY

- INPUT/OUTPUT
- LOGIC INSTRUCTIONS
- COMPARE INSTRUCTIONS
- JUMP INSTRUCTIONS